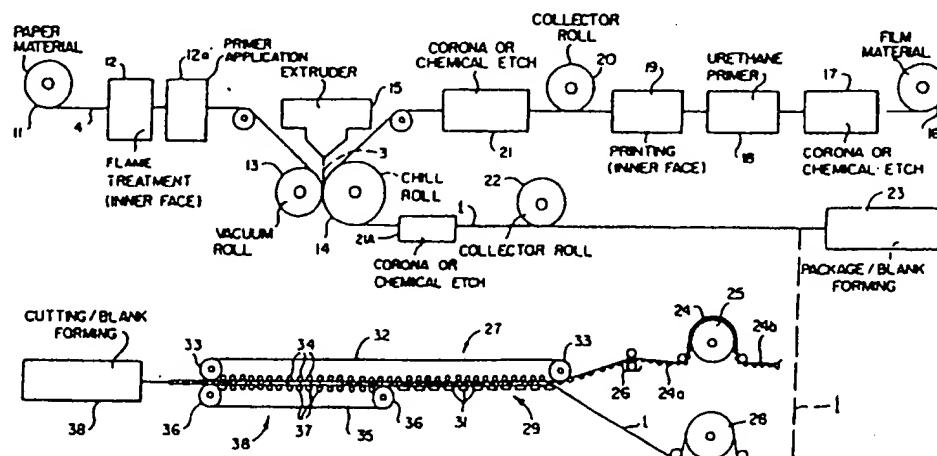




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :	A1	(11) International Publication Number: WO 90/06222
B29C 47/06		(43) International Publication Date: 14 June 1990 (14.06.90)
(21) International Application Number:	PCT/US89/05521	Published
(22) International Filing Date:	11 December 1989 (11.12.89)	With international search report.
(30) Priority data:	281,055 9 December 1988 (09.12.88) US	
(71)(72) Applicant and Inventor:	OLVEY, Michael, Wayne [US/US]; 240 Browns Hill Court, Tyrone, GA 30290 (US).	
(74) Agent:	HINDS, William, R.; 727 Twenty-Third Street South, Arlington, VA 22202 (US).	
(81) Designated States:	AT (European patent), AU, BE (European patent), CH (European patent), DE, DE (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), SU.	

(54) Title: COMPOSITES OF PAPER AND PLASTIC FILM, CORRUGATED PAPERBOARD INCORPORATING SAID COMPOSITES, AND METHODS OF MAKING



## (57) Abstract

Composites of paper and biaxient plastic film, preferably polyester, are made by passing into and through the nip of a pair of nip rolls (13, 14) a web of paperboard (4) and a web of plastic film, with a layer of molten polymer impregnating and bonding agent (3) extruded into the nip between the webs on the entry side of the nip. The product as collected from the nip rolls (13, 14) is a composite (1) comprising paper partially impregnated with solidified polymer, a contiguous layer of solidified polym-

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COMPOSITES OF PAPER AND PLASTIC FILM, CORRUGATED  
PAPERBOARD INCORPORATING SAID COMPOSITES,  
AND METHODS OF MAKING

Field of the Invention

5        This invention relates to composites of paper and plastic film, to corrugated paperboard incorporating such a composite as a liner adhered to the corrugated medium, and to methods of making the composites and the corrugated paperboard. The invention is particularly useful in the  
10      packaging field in the form of containers, but it finds advantageous utility in the fabrication of other products, such as point-of-purchase displays, wall panels, posters, and the like, where a combination of the unique structural features of the invention and high quality graphics is  
15      desired. The invention is particularly felt to satisfy a long-felt need in the area of folding cartons for packaging, whether as primary packaging or secondary packaging, in composite form or as a liner for corrugated paperboard. Although the composite of paper and plastic  
20      film is highly useful and advantageous in itself, it is a particularly important characteristic of the composite that it can withstand the conditions in the "double backer" part of a conventional corrugating machine such that it can be combined with a single faced corrugated  
25      board to form a double faced corrugated board without material deterioration of the composite, which, to my knowledge, has previously been considered impossible as a practical matter. Important characteristics of the composite alone or as incorporated in corrugated paperboard  
30      include scuff and scratch resistance, strength, stretch resistance, tear resistance, separation resistance, resistance to "checking" (cracking in a score line) in the forming of blanks for folding cartons, surface smoothness and gloss, graphics quality and durability, fragrance  
35      barrier quality, and moisture barrier quality.

Background

It is known in the packaging and other arts to form a packaging material in the form of a laminate of paper and plastic film secured together by an adhesive. For instance, particularly in the field of flexible packaging, various films have been laminated to paper with various adhesives, of which polyethylene is one example. For instance, I am aware that a flexible packaging material has been made by laminating "Mylar" polyester film (a product of E. I. DuPont DeNemours & Co. Inc., Wilmington, Delaware, U. S. A.) to thin high-quality paper using a polyethylene adhesive. I am also aware of Peer U. S. patent No. 4,254,173 issued March 3, 1981, which proposes a secondary container packaging material (e.g., a six-pack can or bottle wrap) comprising a paper material laminated to a plastic film. The patent discloses various films, including polyester, various papers such as kraft paper of various weights, and various adhesives, including polyethylene, to bond the film to the paper. It is disclosed in this patent and generally known otherwise that the film can be reverse printed with graphics prior to lamination. To my knowledge, all prior proposals have used the adhering agent only as an adhesive and, thus, have used only that amount necessary to achieve adhesion of the two laminated components. I do not find in the prior art any recognition or appreciation of the possibility of using the adhering agent not just as an adhesive but rather as an impregnant and surface enhancer so as to achieve the characteristics and advantages of the present invention.

It is a basic purpose of the present invention to provide an improved composite of paper or paperboard and plastic film in which the adhering agent is used not merely as an adhesive, but rather as an impregnating and bonding agent and as an enhancer of the paper surface by

essentially forming a new surface. By operating under conditions which ensure substantial impregnation of the adhering agent into the paper, but with a substantial part overlying the surface of the paper and firmly adhering to 5 the plastic film, I obtain a product which is highly resistant to separation, which enhances and protects the graphics quality of reverse printed film or a printed paper surface, which will withstand the rigors of the double-backer portion of a conventional corrugating 10 machine, which minimizes the normal adverse effects of scoring, cutting, folding, etc., in the formation of a carton, and which generally is a new and improved product capable of many uses.

#### Features and Aspects of the Invention

15 In making a composite of paper and plastic film in accordance with my invention, a web of paper and a web of plastic film are passed into and through the nip of a pair of nip rolls, and a layer of molten polymer impregnating and bonding agent is extruded into the nip between the 20 webs on the entry side of the nip. One or more of the speed of the webs, the temperature of the molten polymer, the pressure or spacing of the rolls at the nip, and the rate of extrusion is or are controlled relative to the porosity and surface characteristics of the paper web such 25 that a substantial portion of the molten polymer impregnates partially into and becomes part of the paper web, and a substantial portion lies outwardly of the surface of the paper web and solidifies to form an enhanced surface, which is essentially a new surface, to which the film is 30 bonded and on which it is supported clear of the paper surface. There is collected from the nip rolls a composite comprising paper partially impregnated with solidified polymer, a contiguous layer of solidified polymer having the new surface outwardly of the paper surface, and 35 the plastic film bonded to the new surface. In one pre-

ferred practice of the invention, the inner surface of the film is reverse printed with desired graphics by any of several printing processes. However, the invention also provides improvements where the printing is done on the 5 surface of the paper web itself, since the printed paper surface is protected against scuffing of the print, and hence less ink can be used. Preferably the molten polymer comprises polyethylene, the film is bioriented, and the paper is kraft paper. A particularly preferred film is 10 bioriented polyester. Adherence of the components in the resulting composite is such that peeling essentially is not possible, in that the fibers of the paper will separate before the solidified polymer or the film will peel from the paper. As mentioned above, one of the most 15 important and, indeed, surprising features of the composite is that it can be passed through the double-backer portion of a conventional corrugating machine to form the outside liner of a double-faced corrugated paperboard, which typically involves movement of the exposed face of 20 the film along a hot plate section maintained at temperatures up to about 350°F. Equally as important and surprising is the ability of either the composite or the corrugated paperboard of which it forms the outer liner surface to withstand the rigors of formation into folding 25 carton blanks and folded cartons with little or no separation, "checking", etc. The graphics quality which can be obtained and maintained in the end product is believed to be decidedly superior.

While the foregoing sets forth some of the basic 30 features and aspects of the invention, subsidiary features and aspects of varying degrees of importance will be brought out in or apparent from the ensuing description and illustration of preferred embodiments.

Brief Description of the Drawings

35 Figure 1 is a diagrammatic illustration of apparatus

and steps involved in practicing preferred embodiments of the invention, including the fabrication of the composite and optional incorporation of the composite in a double-faced corrugated paperboard;

5       Figure 2 is a schematic section (not to scale) of the preferred embodiment of the composite; and

Figure 3 is a schematic section of a double-faced corrugated paperboard in which the composite is incorporated as the double face liner.

10 Description of the Preferred Embodiments

Referring to Figure 2 of the drawings, a composite of the invention is shown at 1. The composite includes a paperboard substrate 4, a reverse printed plastic film 2, and an impregnating and bonding polymer 3. As shown, the 15 polymer has been caused to partially impregnate the paper 4 so as to form a substantial thickness of impregnated paper 6. At the same time, a substantial portion of the polymer 3 lies outwardly of the paper surface and essentially forms a new and enhanced surface relative to that 20 of the paper, the reverse printed film 2 being supported on and firmly adhered to the new enhanced surface provided by the polymer 3. The impregnation depth of the polymer into the paper is indicated at 5. The composite 1 differs markedly from the prior art of which I am aware because of 25 the degree of impregnation of the polymer into the paper and the extent to which the new enhanced surface provided by the polymer lies outwardly of the paper surface so as to prevent or at least minimize surface characteristics of the paper affecting the reverse printed film 2. In the 30 conventional prior art laminates of which I am aware, the conventional adhesive does not impregnate the paper at least to any substantial extent, and the fibrous character of the paper surface adversely affects the appearance of the film. This latter characteristic of the prior art can 35 be and probably has been alleviated to some extent by

using a high quality clay-coated paper as the substrate. However, clay-coated paper is expensive and still would not provide the enhanced surface provided by the overlying polymer in accordance with the present invention. Also, 5 clay-coated paper is relatively less porous than conventional kraft paper such that it can be more difficult to obtain the desired impregnation of the polymer. Without substantial impregnation, together with the overlying polymer, the product simply would not withstand the rigors 10 of folding carton formation while providing a high quality, commercially viable end product. Nor would it withstand the conditions in the double-backer portion of a conventional corrugated board making machine.

Figure 2 illustrates a double-faced corrugated paper- 15 board structure which is conventional apart from the incorporation of the composite of the invention as the double face liner, as shown at 10. The otherwise conventional corrugated paperboard structure 7 comprises a corrugated medium 9 and a single face liner 8. While 20 Figure 3 illustrates only one corrugated medium 9 and one single face liner 8, the combination of which is typically known as single faced corrugated board, it will be understood that there are known in the art corrugated paperboard structures consisting of two, three or more 25 single faced boards glued to each other, the single face liner of one single faced board being glued to the corrugated medium of another single face liner so as to form a built-up structure. For instance, such a combination of three single faced boards is typically referred to as 30 triple wall board. It is to be understood, therefore, that the present invention encompasses also such built-up structures in which the composite 10 forms the outer liner, such a built-up structure being exemplified by picturing Figure 3 as including one, two or more additional 35 single faced boards above and adhered to single face liner

8 or to the corresponding single face liner of a further single faced board.

Referring now to Figure 1, there is illustrated in the upper part of the figure a diagrammatic representation 5 of apparatus for and the process of making the composite of paper and plastic film. Collector rolls are shown at 20 and 22 to reflect the fact that various parts of the process may be formed at different times and in different locations, although the process could be continuous. From 10 the point represented by the second collector roll 22, the completed composite can be passed to apparatus, schematically indicated at 23, for formation into a package or blank or any other form, typically involving cutting, scoring, slitting, etc. Alternatively, the completed composite 15 can be passed to a corrugated board making machine for incorporation as the outside liner of a double faced corrugated board. Thus, the lower part of the figure, connected by the broken line, illustrates a typical "double backer" part of a conventional corrugated 20 board making machine as shown in, for example Griffith et al U. S. patent 3,434,901 dated March 25, 1969. From this "double backer" part of the machine, the double faced corrugated board is passed to a conventional cutting or blank forming station shown at 38 where it may be cut into 25 sheets, formed into container blanks, etc.

As shown in the upper part of the figure, paper material, typically conventional kraft paper or paper-board, is led from a roll 11 through a flame treatment station 12 where the inner surface (the upper surface as 30 viewed in Figure 1) is flamed by a gas burner or burners to burn off loose fibers and reduce the water content. This has two effects. First, it provides a better paper surface by burning off loose fibers, dust, etc. Second, by reducing the moisture content, it aids in the later 35 impregnation of the molten polymer into the paper since

the molten polymer seeks to replace the driven-off moisture. The flame treatment is controlled so as not to drive off all the moisture, or too much moisture, particularly from the opposite face of the paperboard, since 5 otherwise the opposite face would be so dry as to re-attract moisture later and cause unwanted curling. Basically, the important point is to slightly lower and control the moisture content on the inner face so as to facilitate the desired later impregnation of the molten 10 polymer.

From the flame treatment station 12 the paper is passed to a primer application station 12a where the upper surface of the paper is primed (e.g., by a roller applicator) with a primer that facilitates and enhances 15 penetration of the molten polymer into the paper when the molten polymer is extruded into the nip of the nip rolls at the combining station. Thus, the primer acts in the nature of a flux for the molten polymer. Such primers are known in the extrusion coating art, and a typical primer 20 usable in the preferred process of the present invention is marketed in the United States by Morton Chemical Company under the brand name or trademark "Adcote."

From the primer application station 12a, the paper 4 passes into the nip between a pair of nip rolls 13 and 14 25 where it is combined with the plastic film and molten polymer 3 which is extruded into the nip from extruder 15 at a high temperature. As shown, nip roll 13 is preferably a vacuum roll, which is simply a roll having its surface covered with very small holes, the interior of the 30 roll being connected to vacuum or suction such that the paper 4 on the surface of the roll 13 can be subjected to a controllable suction to assist or control penetration of the molten polymer into the porous paper. The use of a vacuum roll is not critical to the invention, but it can 35 provide an added measure of control or enhancement of

impregnation. Correspondingly, nip roll 14 is illustrated as a chill roll to quickly set or harden the molten polymer 3 to protect the film, but not so quickly as to adversely affect the desired substantial impregnation of 5 the extremely hot polymer into the paper.

The plastic film entering the nip between the nip rollers starts from a roll 16 of plastic film material. The film is passed through a treatment station 17 where it is subjected to corona discharge treatment or chemical 10 etching of its inner surface (the upper surface as viewed in Figure 1). In general, the corona treatment might be described as bombardment with electrons to create minute surface crevices and cracks. The chemical etching with a solvent or acid can be considered as giving a somewhat 15 scuffed surface. Either surface treatment has a number of desirable effects. Thus, there is a greater bonding area by virtue of the surface "roughening." It is believed that there is less melting resistance at the peaks of the minute crevices or cracks, such that the later heat of the 20 molten polymer tends to melt these peaks and provide better fusion between the film and the polymer. The reduced melting resistance at the peaks tends to slow dissipation of heat. Furthermore, it is believed that the film treatment has what might be termed a "rip-stop" 25 effect, in that it tends to make the point of least resistance against separation of the composite in the paper itself. Still further, the film treatment is believed to increase the heat resistance of the film, among other things, and hence permit more latitude on the 30 extrusion temperature of the molten polymer. As is already known, the plastic film can be purchased with one or both surfaces already pretreated, and either treated or untreated film can be used in the present invention. Preferably even factory pretreated film is treated again, 35 either before or after printing, or both, since treating

after printing does not affect the print quality, and such post-printing treatment is believed to enhance the ultimate bond.

From the corona or chemical etch station 17, the film 5 passes to a primer station 18 where any conventional primer, typical a urethane primer, is applied to the inner surface of the film. Various such primers are known in the art for improving the bond between a plastic film and ink. A urethane primer is believed to avoid or minimize 10 problems which might otherwise occur when the molten polymer contacts the printed film.

From primer station 18, the film passes to a printing operation 19, which can be any of various printing techniques known in the art, such as flexography, offset and 15 gravure, using solvent-based or water-based inks.

Although not illustrated in Figure 1, the printed film optionally can be primed again after printing, which, as stated previously, can eliminate or minimize the possibility of problems when the molten polymer contacts 20 the ink. Thus far, this additional priming step is not considered critical in preferred embodiments of the invention and, therefore, can be considered as optional, although probably advantageous under particular conditions.

As previously stated, the reverse printed film can 25 then be passed to a collector roll for storage, transport, etc. Alternatively, it could be passed directly from the printing station 19, as well as from the collector roll 20, to a further corona discharge treatment or chemical 30 etch operation indicated at 21. This further treatment does not affect the print quality and is believed to facilitate the bond between the molten polymer and the printed film.

The film then passes into the nip between nip rolls 35 13 and 14 to be combined with the molten polymer 3 from

extruder 15 and the paper 4, from which nip rolls the composite passes through a further corona discharge treatment or chemical etch station 21a for treatment of the outer film surface of the composite, and onto a collector roll 5 22. The molten polymer from the extruder 15 is preferably polyethylene of low density and a melt index between 12 and 15. In general, the lowest density polyethylene that gives a satisfactory result is used. However, where the composite is intended for use as the outer face of a 10 double faced corrugated board, there should be used the lowest density polyethylene that will withstand the temperature and other conditions in the "double backer" part of the corrugated board making machine.

Conditions are controlled and varied at the combining 15 station to give the desired product. Thus, impregnation of the molten polymer, preferably polyethylene, into the paper is controlled by controlling the temperature of the molten polymer and the machine speed, the machine speed being controlled by controlling the speed of the take-up 20 or collector roll 22. The thickness of the molten polymer passing into and through the nip is controlled by controlling the speed of the take-up or collector roll, and hence the rate of travel of the paper and film through the nip. Additionally, the spacing of the nip rolls can 25 be varied. In a preferred arrangement, one of the nip rolls is spring loaded or pneumatically loaded, and the spring pressure or pneumatic pressure can be controlled. In general, although practically any of the conditions at the combining station could be controlled and varied as 30 needed, including the pressure or spacing of the nip rolls, the thickness, temperature and viscosity of the molten polymer, the speed of the webs, and the rate of extrusion, generally it suffices to controllably vary only three conditions, these being the take-up roll speed, the 35 temperature of the molten polymer, and the spring or

pneumatic pressure on the adjustable nip roll. Theoretically it would be possible to vary the speed by controllably varying the speed of the nip rolls, but this would be an unnecessary complication relative to varying the  
5 speed of the take-up roll.

The schematically illustrated apparatus for making the composite should be considered as merely typical, although presently preferred. In general, the process of making the composite can be carried out on properly  
10 controlled conventional machinery normally used for merely laminating paper, or machinery normally used for extrusion coating paper if modified to additionally handle the film. In the typical practice of the process, the treated and reverse printed film is taken up on collector roll 20,  
15 which is thereafter transported to and mounted on the combining machinery, appropriately modified as required. As previously mentioned, this could be conventional machinery for extrusion coating paper modified to handle and treat the plastic film.

20 The primary purpose of the corona discharge treatment or chemical etch treatment indicated at 21a is to facilitate gluing of the outer surface of the film to itself or some other surface in the fabrication of boxes, containers, etc. Thus, it will be understood that the treatment at station 21a is of the outer surface of the film  
25 part of the composite.

The package/blank forming operation indicated at 23 may be any conventional operation for forming carton blanks, cartons, boxes, containers, or simply cutting the  
30 composite into individual sheets for use as desired.

To combine the completed composite as part of a corrugated structure, the roll of composite can be mounted in a conventional corrugating machine as the supply roll for the outside liner of double faced corrugated board, as  
35 diagrammatically indicated in the lower part of Figure 1.

As seen in the lower part of Figure 1, which shows a typical, prior art, double backer operation, single faced corrugated board 24, consisting of a web of corrugated medium 24a having a coextensive web of liner 24b bonded to 5 tips of the corrugations on one side thereof, is trained over a preheater drum 25. The single face 24, after having its temperature raised to perhaps 150-200°F by the preheater drum 25, is then passed over an adhesive applicator 26 and into the combining section generally indicated at 27. The composite 1, constituting a web of outside liner, is also trained over a preheater drum 28 and thence into the combining section 27 where it is pressed against the adhesive covered flute tips of the single faced board. Of course, the paper face of the composite 10 is the upper face as viewed in the lower part of Figure 1, such that the corrugated medium 24a is pressed against the paper face of the composite 1. The combining section consists, basically, of two parts: a hot plate section 29 and a draw section 38. Heat is applied in the 15 hot plate section by a series of steam heated chests 31 having their upper portions aligned to provide a heated, substantially continuous surface. An endless belt 32, trained about a pair of driven rollers 33 and having a series of smaller rollers 34 bearing on its lower reach, 20 serves to press the single faced board 24 and composite 1 toward the steam chest 31. A second belt 35, trained about driven rollers 36 and pressure rollers 37, cooperates with the downstream portion of the belt 32 to grip 25 the assembled single faced board and composite outside liner 1 and draw them through the double backer apparatus. The completed double faced board is then passed to an appropriate operation station indicated at 38 for cutting, box blank forming, or whatever operation is desired. 30 Apart from the incorporation of the novel composite as the outside liner, the lower portion of Figure 1 may be 35

regarded as conventional, and, indeed, this is one of the great advantages of the invention in that this is the first instance of which I am aware in which a double faced corrugated board can be made on a conventional double backer corrugating machine while providing an outside liner having the features and characteristics of the composite of the present invention. Thus, the invention provides not only a new and advantageous composite of paper and plastic film useful in itself, but also provides a composite which can successfully withstand the conditions involved in passing through the double backer part of a conventional double faced board corrugating machine as the outside liner.

In the finished composite, adherence of the original components is such that they are essentially inseparable, that is, peeling is practically impossible. The weakest point against separation is in the unimpregnated part of the paper, and the fibers of the paper will separate before the molten polymer, preferably polyethylene, will peel from the paper, and typically before the plastic film will peel from the polyethylene impregnant and bonding agent. It is indeed surprising that the composite can go through a double backer corrugator with no or little damage to the film or the polyethylene impregnant and bonding agent, considering that the heat plates of the corrugator typically involve temperatures of up to 350°F, a temperature at which regular adhesives will not stand up and, indeed, a temperature at which it is believed that the polyethylene of conventional "poly mounted" laminates will not stand up. Furthermore, polyethylene being moisture resistant, the new composite with impregnated polyethylene is highly resistant to separation even when wet.

Successful runs of the composite have been made in a Langston 87" XB corrugator, 1965 model, the heat table in

the double backer being at a temperature of approximately 340°. The composite should run well in similar conventional machines under normal commercial operating conditions or, perhaps in some instances, with minimal 5 deviations from normal commercial operating conditions. It is difficult to attribute the ability of the composite to successfully pass through a double backer corrugator to any particular feature or features. However, a tentative theory is that the substantial amount of polyethylene 10 impregnating and bonding agent present in the composite softens slightly in passing over the hot plate, so as to act as a cushion and reduce or eliminate scuffing of the film as it drags over the hot plate. Also, it may be that the paper and the substantial amount of polyethylene 15 impregnated therein act as a heat sink to prevent excessive softening or bubbling of the polyethylene overlying the paper and forming the new or enhanced surface to which the film is bonded.

In the making of the composite, conditions should be 20 controlled such that in the completed composite there generally is at least about 0.5 mil of polyethylene between the reverse printed film and the surface of the paper. This generally ensures that paper fibers, with or without the preferred flame treatment operation, do not 25 contact the inner surface of the film. In general, in the extracted composite the polyethylene should be generally uniform over the area of the composite in amount of at least about five pounds per thousand square feet of composite, with preferably at least about three pounds of 30 polyethylene per thousand square feet being generally uniformly present between the printed film and the surface of the paper to form the new and enhanced surface. Where the paper is of the order of forty-two pound (forty-two pounds per thousand square feet) liner board, the preferred minimum 35 total polyethylene is at least about six pounds per

thousand square feet of composite, with a preferred range being about nine pounds to fourteen pounds per thousand square feet of composite. Preferably the extruded molten polymer, preferably polyethylene, passes into the nip at a 5 rate corresponding to a continuous thickness of at least about one mil relative to the speed of the webs, and advantageously this continuous thickness should be at least about 1.5 mils. As previously mentioned, impregnation of the polyethylene or other polymer into the paper 10 may be controlled by controlling the temperature of the molten polyethylene and the machine speed. In general, decreasing the temperature of the polyethylene decreases impregnation. Therefore, the polyethylene should be kept at a high temperature, typically about 600°F or higher. 15 If clay coated paperboard is used in the process, it is generally necessary to use a very high temperature for the polyethylene so as to ensure migration through the clay coating and impregnation into the paperboard. The clay coated paperboard, even though it has an improved surface 20 relative to uncoated kraft paper, generally should be flame treated about the same as uncoated kraft paper, but possibly slightly less. If using clay coated paperboard, it is important not to drive off too much moisture, particularly from the opposite face of the paperboard, since 25 otherwise the opposite face will reattract moisture and cause curling, possibly more so than for uncoated kraft. While usable in the invention, clay coated paperboard is not preferred because of its expense, one feature of the invention being the provision of a high quality product 30 from a low grade or relatively inexpensive paper or paperboard. It is also to be noted that in general machine finished paper does not work as well as plain kraft paper or paperboard. This is believed to be because machine finished paper has a polished surface, and is not suf- 35 ficiently porous for the most advantageous practice of the

invention. In general, natural kraft paper, unbleached and uncoated, works well in the practice of the invention.

In general, the printing of the film will involve continuous cover printing where high quality graphics are desired, although this is not critical to the invention for some uses where high quality graphics are not needed or where only the structural features are desired. However, as a variant of the invention as previously described, high quality graphics could be obtained by printing the film without continuous print cover, that is, with some unprinted areas. The film so printed then could be extrusion mounted on metallized film, which then would be combined with paperboard to form a composite as previously described. The metallized surface of the metallized film should be toward the paperboard.

Apart from the packaging field, a principal use of the composite is in the manufacture of wall paneling by laminating the composite to wallboard such as particle board or plywood, the paper surface being laminated to the wallboard. The composite for such use is made in the same general manner previously described, except that a lighter weight of paper can be used in the composite, such as ten pound or twelve pound kraft paper. This results in a scuff resistant panel of high graphics quality. Where high gloss is undesired, delustered film such as delustered "Mylar" film may be used. Alternatively, polypropylene film could be used. The film need not be, but preferably is, bioriented since this produces a better quality product, and avoids fabrication problems that might arise because of the relatively less stability of unoriented film.

An outstanding characteristic of the composite of the invention relative to conventional laminates is its resistance to separation, "checking," cracking, etc. when being scored to form box blanks, for instance, or when

being folded into completed boxes or other containers. Scoring involves substantial compression in a small area, and in many laminates can result in separation or delamination, which does not occur with composites in accordance  
5 with the present invention. The reason for this is difficult to pen down to a particular feature, but it is believed to result from a combination of the substantial impregnation of the polyethylene into the paper and the overall cushioning effect provided by the impregnated and  
10 unimpregnated polyethylene. No doubt the preferred bioriented polyester film contributes to this also. In general, containers of which the composite of the invention forms the outer surface have a smooth, high-gloss surface that will not separate or "check" in the corners  
15 after scoring.

Cartons or boxes made from the composite per se or in its corrugated form not only provide high strength and resistance to crushing, but also are moisture proof or resistant and retain fragrance, characteristics which are  
20 extremely important in primary container packaging for products such as laundry detergents, soap, etc.

The paper or paperboard used in the composite of the present invention generally may be any paper suitable for folding cartons or corrugated board or as a substrate for  
25 laminating to a backing such as wallboard. The preferred paper is kraft paper of a weight known as liner board or paperboard. As is well-known in the art, kraft paper is paper produced by a chemical cooking process using sodium hydroxide and sodium sulfide, and there are many different  
30 types of kraft paper manufactured with various additives and treatments for various applications. Natural kraft paper generally refers to kraft paper which has not been bleached or dyed. Of course, paper itself refers to a web of cellulosic fibers in sheet form. The invention can  
35 also make good use of reprocessed paper, that is, not

virgin kraft paper. In general, the heaviest paper presently contemplated as useful in the invention is twenty-two point kraft liner board having a weight of about ninety pounds per thousand square feet. The term "point," 5 as generally used in the industry and herein, means a thickness of one-thousandth of an inch for each point. For composites to be incorporated in a corrugated structure, a preferred paper is natural kraft paper (unbleached and uncoated), twenty-six pounds per thousand square feet 10 or heavier, and commonly about nine point. Other useful paperboard for corrugated structure incorporation is twenty-three pound paper, with thirty-three pound to forty-two pound paper being also typically useful. For some uses of the composite itself as secondary packaging, 15 fifty pound, nine point kraft would be a typical example. In general, one should use the least expensive and lowest grade paper that results in a composite having the necessary characteristics for the particular project.

The much preferred film for use in the composite of 20 the invention is bioriented polyester such as DuPont's "Mylar" film, which is a strong, tough, clear plastic film made principally from polyethylene terephthalate and used widely in packaging, particularly flexible packaging. Polypropylene might be used where less scuff resistance is 25 needed, but the polypropylene and polyethylene impregnant and bonding agent preferably should be cross-linked by radiation after formation of the composite. Radiation cross-linking itself is well-known in the art. The presently preferred "Mylar" film is one-half mil (forty-eight-gauge). Where the composite is to be used in a 30 corrugated structure, the film should be a bioriented film of high heat resistance sufficient to successfully go through the double-backer part of a conventional corrugator having a heat plate or table operating at about between 250° and 350°.

The preferred impregnating and bonding agent is

polyethylene, typically a low density polyethylene having a melt index between twelve and fifteen. For use in a composite to be incorporated in a corrugated structure,  
5 one should generally use the lowest density polyethylene that will successfully go through the double-backer part of a conventional corrugated board making machine. Examples of suitable polyethylene resins are Eastman 1390, of 0.915 density and melt index of fifteen, manufactured  
10 by a subsidiary of Eastman Kodak Company. Another example is DuPont's "Alathon" 1570, a low density polyethylene resin known for use in flexible packaging.

As previously stated, the molten polyethylene preferably is extruded at 600°F or higher, but this should be  
15 varied as needed to achieve the desired substantial impregnation into the paper. In general, the extrusion temperatures used are substantially higher than would be necessary merely to adhere two components together in a conventional laminating process, the higher temperatures  
20 facilitating the impregnation. As an example, if the molten polyethylene is of 1.5 mils continuous thickness out of the extruder, conditions should be maintained such that at least about one-half mil will penetrate and impregnate into the liner board.

25 As a typical example of making a composite for use as the outside liner for a double-faced corrugated board, one could use one-half mil bioriented polyester film (typically "Mylar"), twenty-three pound paper, and at least one mil thickness of polyethylene out of the  
30 extruder and through the nip. As another typical example, the composite would involve forty-eight gauge (one-half mil) bioriented polyester film, a minimum of 1.5 mils thickness polyethylene out of the extruder and through the nip (of which at least one-half mil should penetrate and  
35 impregnate the liner board), the polyethylene being

extruded between about 600° and 640°F and being of low to medium density, and twenty-six pound low density kraft paper of nine point thickness. An alternative paper could be thirty-three pound to forty-two pound kraft paper. As 5 an example of a composite for use in secondary packaging, such as a "six-pack" or "twelve-pack" for cans or bottles, there could be used sixteen point, fifty pound kraft paper, forty-eight gauge bioriented polyester film, and two mils continuous thickness of polyethylene out of the 10 extruder and through the nip.

Although the illustrated embodiment involves reverse printing of the film, and this technique generally will be used where the highest quality graphics are desired, it is to be understood that the invention is advantageous also 15 where the printing is done on the paper surface, that is, printing the paperboard or liner board instead of the film. A principal advantage of the invention in such embodiments is that the printing on the paper is well protected against scuffing, and hence less ink can be used. 20 In typical paperboard printing, it is necessary to lay down a fairly heavy coat of ink to allow for scuffing and the like. With the printed paperboard well protected by the polyethylene and the film in the present invention, this is not a problem. Thus, one can use less ink while 25 achieving better quality printing, using, for example, a 120 line screen. In general, where the paperboard is to be printed, it is preferred to use clay coated kraft paper or solid bleached sulfate kraft paper or paperboard or linerboard, typically known in the art as SBS kraft liner- 30 board. Both products have an improved surface relative to untreated kraft paper. In such embodiments of the invention, not only is there an advantage in the initial printing of the paperboard and in the protection of this printing, but there is also an advantage in appearance 35 arising from the smoothness of the film supported on the

new or enhanced polyethylene surface, such that the characteristics of the paper do not carry through to the film, and hence there is improved film gloss where desired.

- 5        As mentioned previously, it is known in the art to laminate paper and polyester film, including bioriented polyester film, using a polyethylene adhesive, in, for instance, flexible packaging. It is also known in the art to produce a laminate of polyester and paperboard by
- 10      coextruding polyester and polyethylene adhesive onto paperboard which has been pretreated by flame priming, the polyethylene adhesive layer being thinner than the one-half mil polyester outer layer, as described in Thompson U. S. patent 4,455,184, issued June 19, 1984. Kozlowski U. S. patent No. 4,064,302 relates to flexible, semi-rigid fabricating material, and mentions "Mylar," among others, bonded to paper or paperboard by an adhesive coating of thermoplastic polyethylene. The previously mentioned Peer U. S. patent 4,254,173 discloses a secondary container
- 15      packaging material for use in six-pack can wraps, etc. comprising a laminate of a paper material laminated to a plastic film, which paper may be natural kraft paper among others, which film may be polyethylene terephthalate, among others, the film being reverse printed, a mentioned
- 20      adhesive being a polyethylene resin, among others. However, these known or proposed products do not respond to the structural and appearance features of the present invention and are all believed to be distinctly different from the present invention.
- 25      In the foregoing, I have described and illustrated the inventive concepts with reference to illustrative and presently preferred embodiments of my invention. However, the scope and substance of my invention are as set forth in the ensuing claims as interpreted in the light of the
- 30      foregoing description and illustrations, and it is
- 35

intended that the claims be construed as including alternative embodiments, except insofar as limited by the prior art.

I Claim:

1. A method of making a composite of paper and plastic film, comprising passing into and through the nip of a pair of nip rolls a web of paper and a web of plastic film, extruding a molten plastic impregnating and bonding agent into the nip between said webs of a thickness such that the combined thicknesses of the molten plastic, the paper web and the plastic film web passing into the nip are greater than the least dimension of said nip, the porosity of the paper, the pressure of the nip rolls, and the thickness, temperature and viscosity of said molten plastic being such that part of said molten plastic agent impregnates partially into and becomes part of said paper web and a substantial part of the plastic agent extends outwardly of the paper web surface and forms a new solidified surface on which the plastic film is supported and to which it is firmly bonded, and extracting from the nip rolls a composite consisting of paper at least partially impregnated with the plastic impregnating and bonding agent so as to be inseparable therefrom without destruction of the paper, the new surface of the solidified plastic overlying the paper surface, and the plastic film web supported on and bonded to the new surface of solidified plastic clear of the paper web surface, the thickness of the composite being less than the combined thicknesses of the paper web, the extruded layer of molten plastic passing into the nip, and the plastic film web.

2. A method as claimed in Claim 1 wherein the inner surface of said plastic film is provided with a decorative surface coat before passing into said nip.

30 3. A method as claimed in Claim 2 wherein the inner surface of said plastic film is printed before passing into said nip.

4. A method as claimed in Claim 3 wherein said molten plastic impregnating and bonding agent is polyethylene, said plastic film is bioriented polyester film, and said paper is uncoated kraft paper.

5 5. A method as claimed in Claim 4 wherein the extruded layer of molten polyethylene passing into the nip is of substantially greater thickness than said bioriented polyester film and substantially less thickness than said paper web.

10 6. A method as claimed in Claim 5 further comprising adhering the paper surface of said composite to the flute tips on one side of the corrugated medium of single-faced corrugated paperboard so as to form double-faced corrugated paperboard.

15 7. A method as claimed in Claim 6 wherein said composite is adhered to the flute tips of said corrugated medium by adhesively applying the paper surface of the composite to the exposed flutes of a single-faced corrugated paperboard in the double-facer combining section of  
20 a corrugating machine having a hot plate section such that the composite forms the outside liner of a double-faced corrugated paperboard and the exposed face of said film moves along the hot plate section in passing through the machine.

25 8. A method as claimed in Claim 7 wherein said double-faced corrugated paperboard is subsequently subjected to one or more of cutting, scoring, slotting and slitting to form container blanks.

9. A method as claimed in Claim 4 further comprising flame treating the inner surface of said paper before passing into said nip so as to remove some of the loose or protruding fibers and lower the water content so as to 5 provide a smoother paper surface, enhance impregnation by the molten polyethylene to replace the lowered water content, and minimize the risk of paper surface fibers extending to the new plastic surface.

10. A method as claimed in Claim 4 wherein said 10 extruded molten polyethylene is extruded into said nip at a temperature of approximately 600°F, and the nip roll contacted by the film is a chill roll.

11. A method as claimed in Claim 10 wherein said 15 polyester film is pretreated on its inner surface by a pretreatment selected from corona treatment and chemical etching.

12. A method as claimed in Claim 10 wherein the inner surface of the film is treated with a urethane primer before printing.

20 13. A method as claimed in Claim 4 wherein the materials and operating conditions are such that in the extracted composite there is at least about 0.5 mil of polyethylene between said printed film and the surface of the paper.

25 14. A method as claimed in Claim 4 wherein the operating conditions are such that in the extracted composite the polyethylene is generally uniform over the area of the composite in an amount of at least about five pounds per thousand square feet.

15. A method as claimed in Claim 14 wherein in the extracted composite at least about three pounds of polyethylene per thousand square feet is generally uniformly present between said printed film and the main surface of the paper.

16. In a corrugated paperboard structure comprising at least one corrugated intermediate member and two substantially flat outer liners adhesively secured to flute tips of corrugations of an intermediate member, the improvement wherein one of said outer liners comprises a composite comprising a substrate of paper, a solidified plastic impregnating and bonding agent impregnated partially into the paper substrate from one face thereof and overlying the surface of said one face and forming a plastic surface outwardly of the surface of said one face of the paper, and a bioriented plastic film supported on and bonded to said plastic surface, said paper substrate having its other face adhesively secured to flute tips of said corrugations such that said film forms the outer surface of said one liner.

17. A corrugated paperboard structure as claimed in Claim 16 wherein said film is transparent and reverse printed on its inner face.

18. A corrugated paperboard structure as claimed in Claim 17 wherein said solidified plastic is polyethylene, and said bioriented plastic film is polyester.

19. A corrugated paperboard structure as claimed in Claim 18 wherein said corrugated paperboard structure is a container blank.

20. A composite of paper and plastic film comprising a substrate of paper, a solidified plastic impregnating and bonding agent partially impregnated into and forming part of the paper substrate and overlying one surface of  
5 the paper and forming a new surface outwardly of the paper surface, and a bioriented polymer film supported on and bonded directly to said new surface of solidified plastic clear of said paper surface.

21. A composite as claimed in Claim 20 wherein said  
10 film is reverse printed on its inner surface.

22. A composite as claimed in Claim 21 wherein said solidified plastic impregnating and bonding agent is polyethylene and said film is bioriented polyester film.

23. A composite as claimed in Claim 22 wherein said  
15 composite is a cut-and-scored blank for forming into a container.

24. A method of making a composite of paper and film comprising passing into and through the nip of a pair of nip rolls a web of paper and a web of plastic film;  
20 extruding a layer of molten polymer impregnating and bonding agent into the nip between the webs on the entry side of the nip; relatively controlling one or more of the speed of the webs, the temperature of the molten polymer, the pressure or spacing of the rolls at the nip, and the  
25 rate of extrusion, relative to the porosity and surface characteristics of the paper web such that a substantial portion of the molten polymer impregnates partially into and becomes part of the paper web and a substantial portion lies outwardly of the surface of the paper web and  
30 solidifies to form a new surface to which the film is

bonded and on which it is supported clear of the paper surface; and collecting from the nip rolls a composite comprising paper partially impregnated with solidified polymer, a contiguous layer of solidified polymer having  
5 said new surface outwardly of the paper surface, and the plastic film bonded to said new surface.

25. A method as claimed in Claim 24 wherein the inner surface of said film is reverse printed.

26. A method as claimed in Claim 25 wherein said  
10 molten polymer comprises polyethylene, said film is bioriented, and said paper is kraft paper.

27. A method as claimed in Claim 26 wherein said film is bioriented polyester.

28. A method as claimed in Claim 25 wherein the  
15 reverse printed film is pretreated on its inner surface by a pretreatment selected from corona treatment and chemical etching.

29. A method as claimed in Claim 24 wherein said film is pretreated on its inner surface by a pretreatment  
20 selected from corona treatment and chemical etching.

30. A method as claimed in Claim 24 wherein the nip roll adjacent said paper web is a vacuum roll imposing suction on said paper web, and the nip roll adjacent said plastic film web is a chill roll.

25 31. A method as claimed in Claim 24 wherein the operating conditions are such that the extruded molten polymer passes into the nip at a rate corresponding to a continuous thickness of at least about 1 mil.

30 32. A method as claimed in Claim 31 wherein said con- tinuous thickness is at least about 1.5 mils.

33. A method as claimed in Claim 31 wherein the operating conditions are such that the solidified polymer lying outwardly of said surface of the paper web is of at least about 0.5 mil thickness.

5        34. A product made by the process of Claim 24.

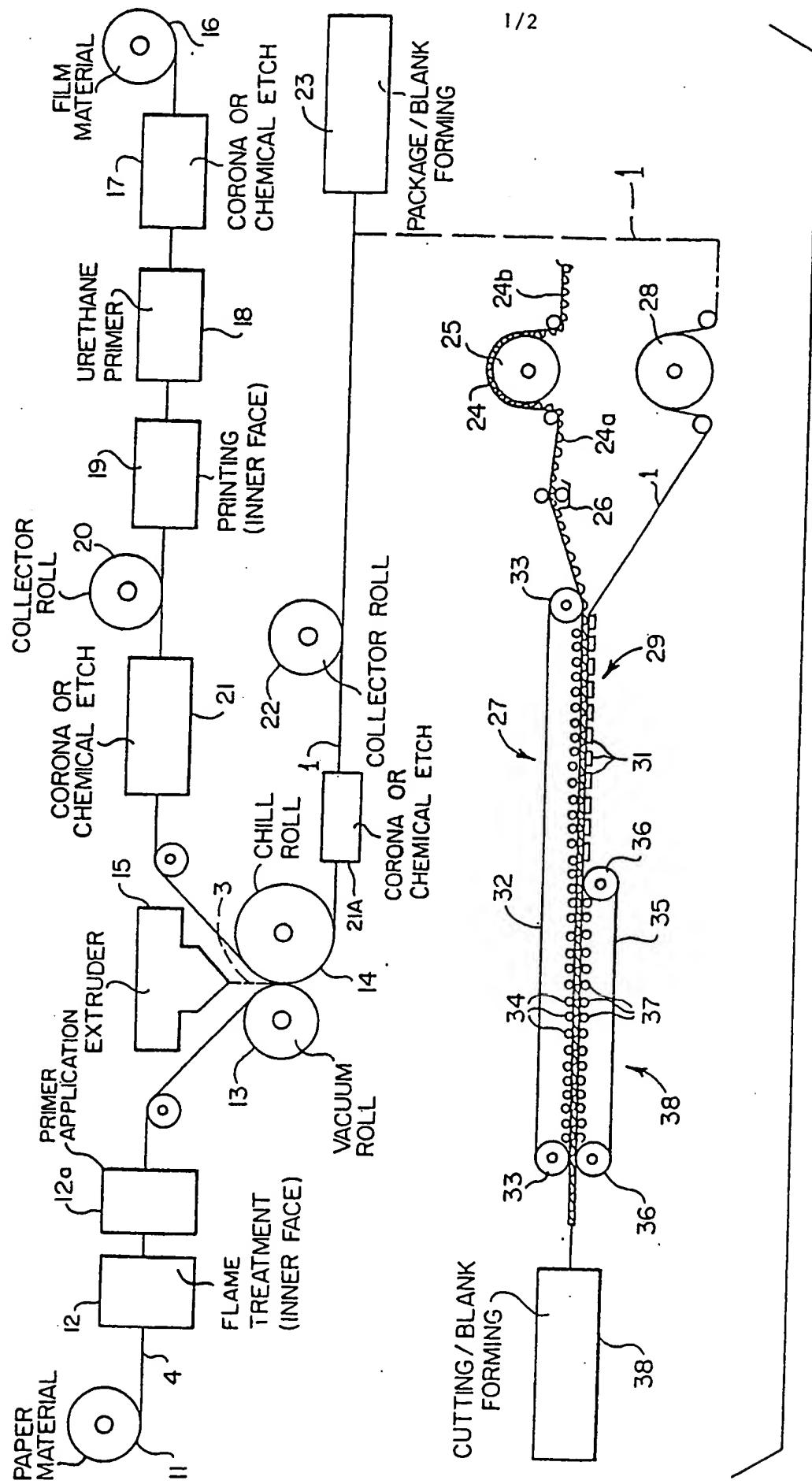


FIG. 1

2/2

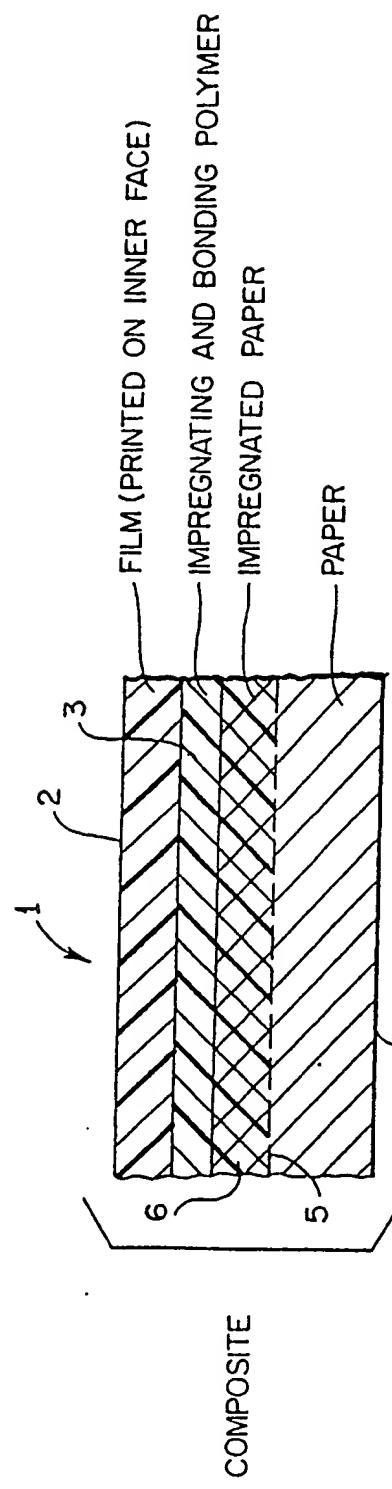


FIG. 2

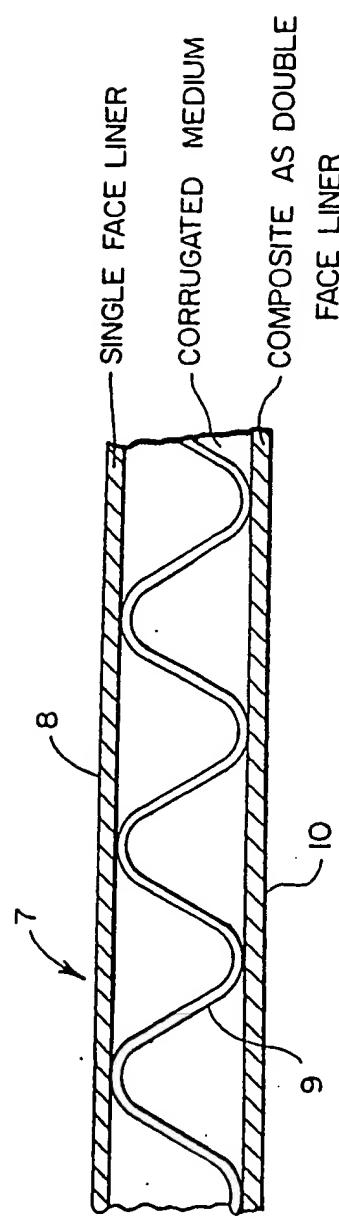


FIG. 3

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US89/05521

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) <sup>6</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC  
 IPC(5): B29C 47/06  
 U.S. CL: 156/244.11

## II. FIELDS SEARCHED

Classification System	Minimum Documentation Searched <sup>7</sup>
	Classification Symbols
U.S.	156/89, 201, 210, 243, 244.11, 244.16, 244.22, 244.24, 244.27; 427/223, 307, 308, 314, 326, 356, 361, 365; 428/204, 205, 215, 507, 512, 513.

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup>

Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US, A 3,862,869 (Peterson et al) 28 January 1975, See figs. 1-3 and column 2, line 4 through column 4, line 10.	1-34
Y	US, A, 4,254,173 (Peer) 03 March 1981, See entire document	2-5, 9-15, 21-23 and 25-28
Y	US, A, 4,765,855 (Geoffroy-Dechaume et al) 23 August 1988, See figs. 5-10 and column 3, line 54 through column 4, line 22.	6-8 and 16-19
Y	GB, B, 729,949 (Hunt) 23 March 1955, See entire document.	1-34

\* Special categories of cited documents: <sup>10</sup>

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

01 March 1990

Date of Mailing of this International Search Report

21 Mar 1991

International Searching Authority

ISA/US

Signature of Authorized Officer

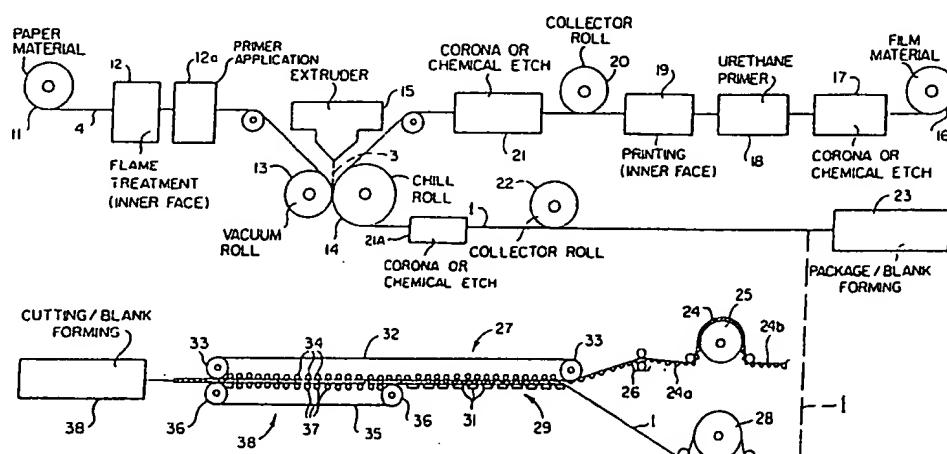
*Veronica E. Weston for  
CALEB WESTON*



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :	A1	(11) International Publication Number:	WO 90/06222		
B29C 47/06		(43) International Publication Date:	14 June 1990 (14.06.90)		
(21) International Application Number:	PCT/US89/05521	Published <i>With international search report.</i>			
(22) International Filing Date:	11 December 1989 (11.12.89)				
(30) Priority data:					
281,055	9 December 1988 (09.12.88)	US			
(71)(72) Applicant and Inventor:	OLVEY, Michael, Wayne [US/US]; 240 Browns Hill Court, Tyrone, GA 30290 (US).				
(74) Agent:	HINDS, William, R.; 727 Twenty-Third Street South, Arlington, VA 22202 (US).				
(81) Designated States:	AT (European patent), AU, BE (European patent), CH (European patent), DE, ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), SU.				

(54) Title: COMPOSITES OF PAPER AND PLASTIC FILM, CORRUGATED PAPERBOARD INCORPORATING SAID COMPOSITES, AND METHODS OF MAKING



## (57) Abstract

Composites of paper and bioriented plastic film, preferably polyester, are made by passing into and through the nip of a pair of nip rolls (13, 14) a web of paperboard (4) and a web of plastic film, with a layer of molten polymer impregnating and bonding agent (3) extruded into the nip between the webs on the entry side of the nip. The product as collected from the nip rolls (13, 14) is a composite (1) comprising paper partially impregnated with solidified polymer, a contiguous layer of solidified polymer having the new surface outwardly of the paper surface, and the plastic film bonded to the new surface.